

Study of the away side jet in Au + Au and Cu + Cu collisions in PHENIX

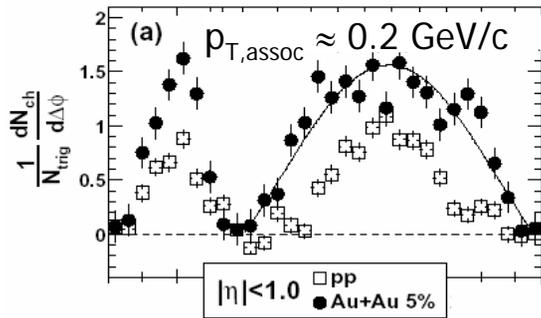
Jiangyong Jia for the PHENIX Collaboration



- pT evolution of the away side correlation
- High pT Au+Au /Cu+Cu comparison
- Intermediate pT correlation

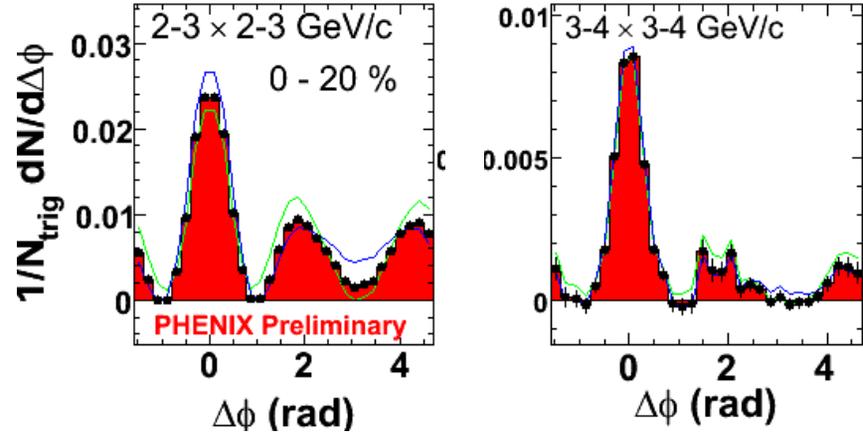
Evolution of away-side jet shape

low p_T



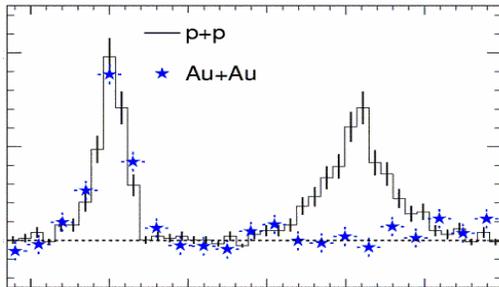
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Intermediate p_T

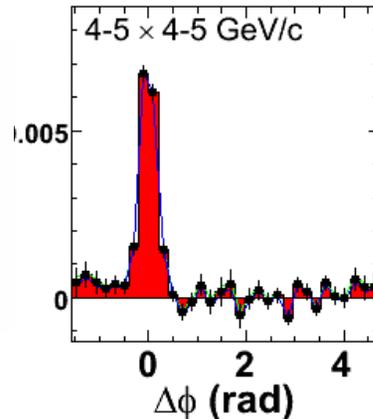


Moderate high p_T

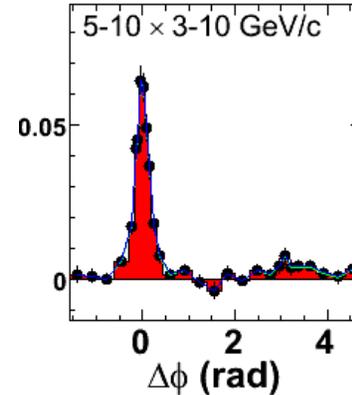
4-6 x 2-4 GeV/c
 $p_{T,assoc} \approx 2$ GeV/c



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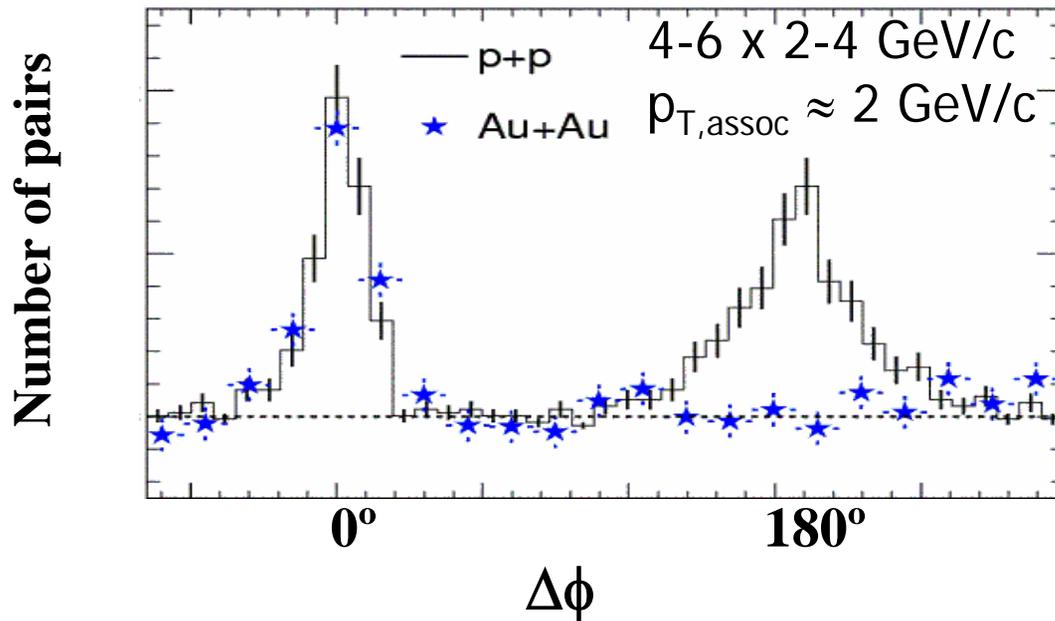


high p_T



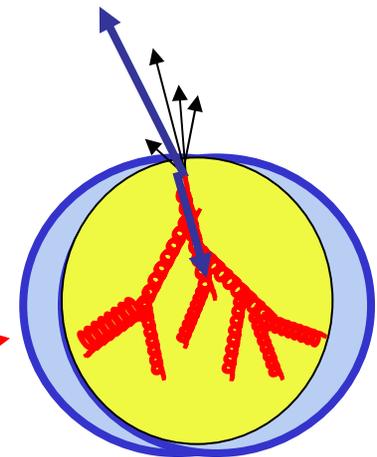
Do we have a (qualitative) picture?

Di-jet correlation at moderate high p_T



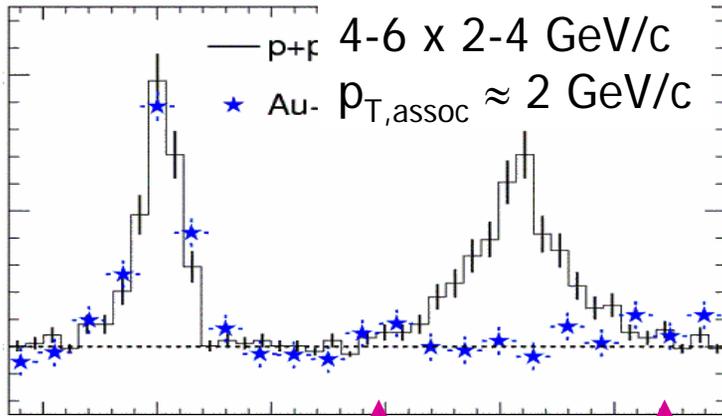
➤ In Au+Au collisions we see only one “jet” at a time !

➤ Jet quenching!

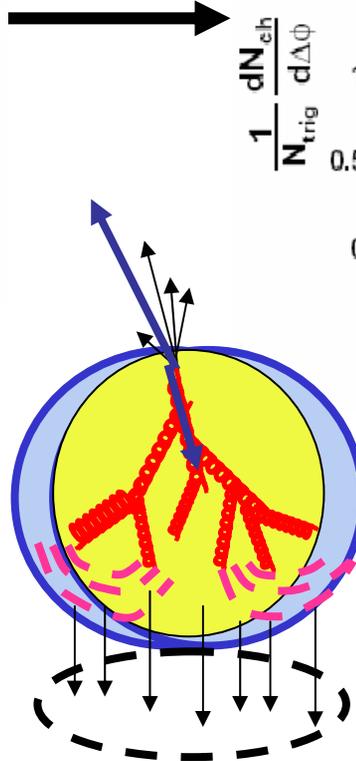
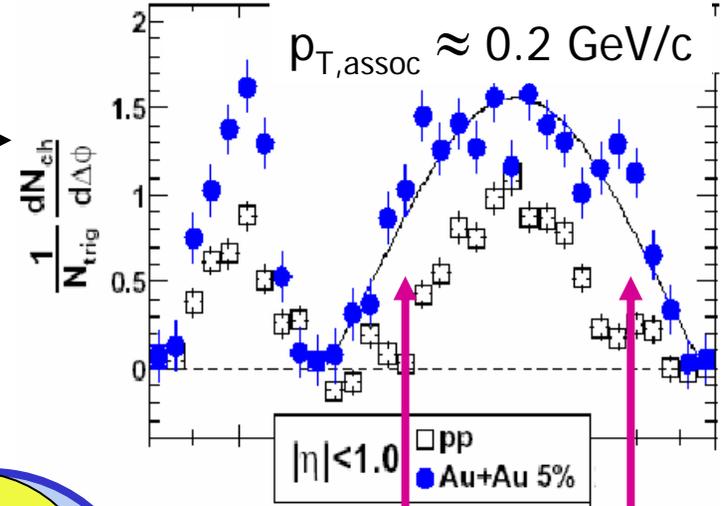


What happens to the lost energy?

Moderate high p_T Away-side suppression



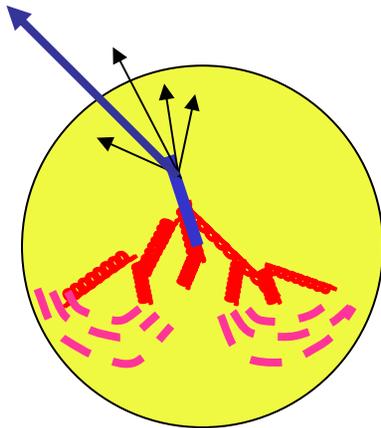
Low p_T Away-side enhancement



Lost energy recovered at low p_T

How the medium responds to the jet?

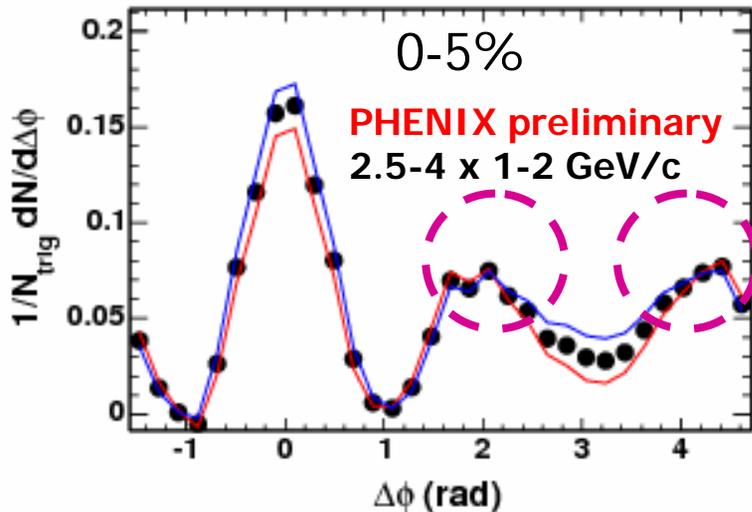
How the medium responds to the jets?



Mach cone/shock wave?

Jets travel faster than the speed of sound in the medium

Create shock wave at: $\cos(\theta) = c_s/c$

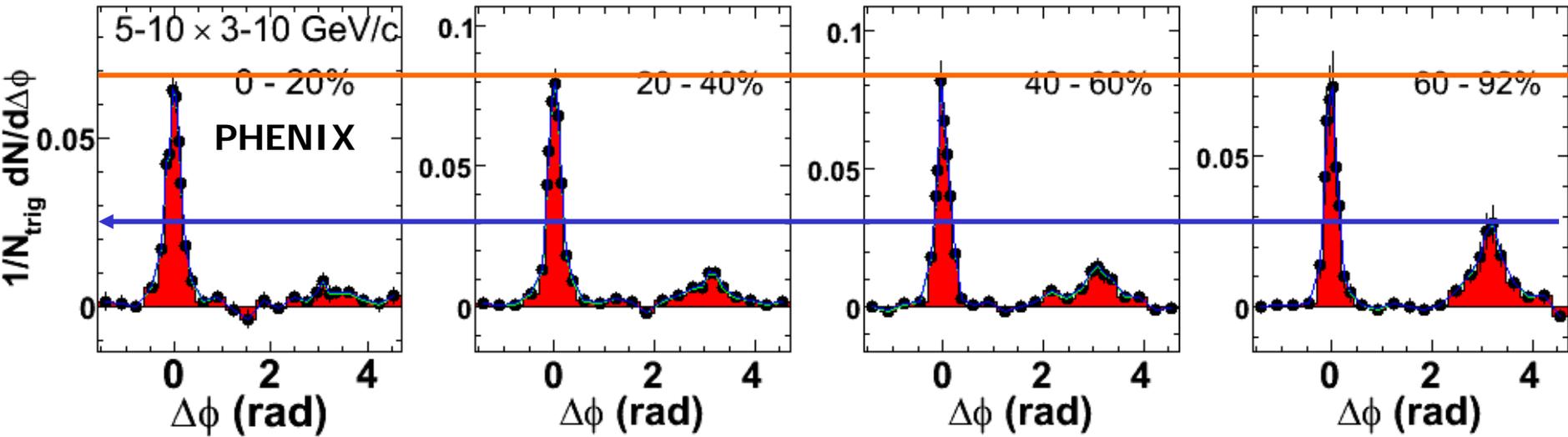


QCD "shock wave"



Other possible mechanisms:
Cherenkov radiation, bending jet,
Gluon radiation...

Di-jets at high p_T : PHENIX

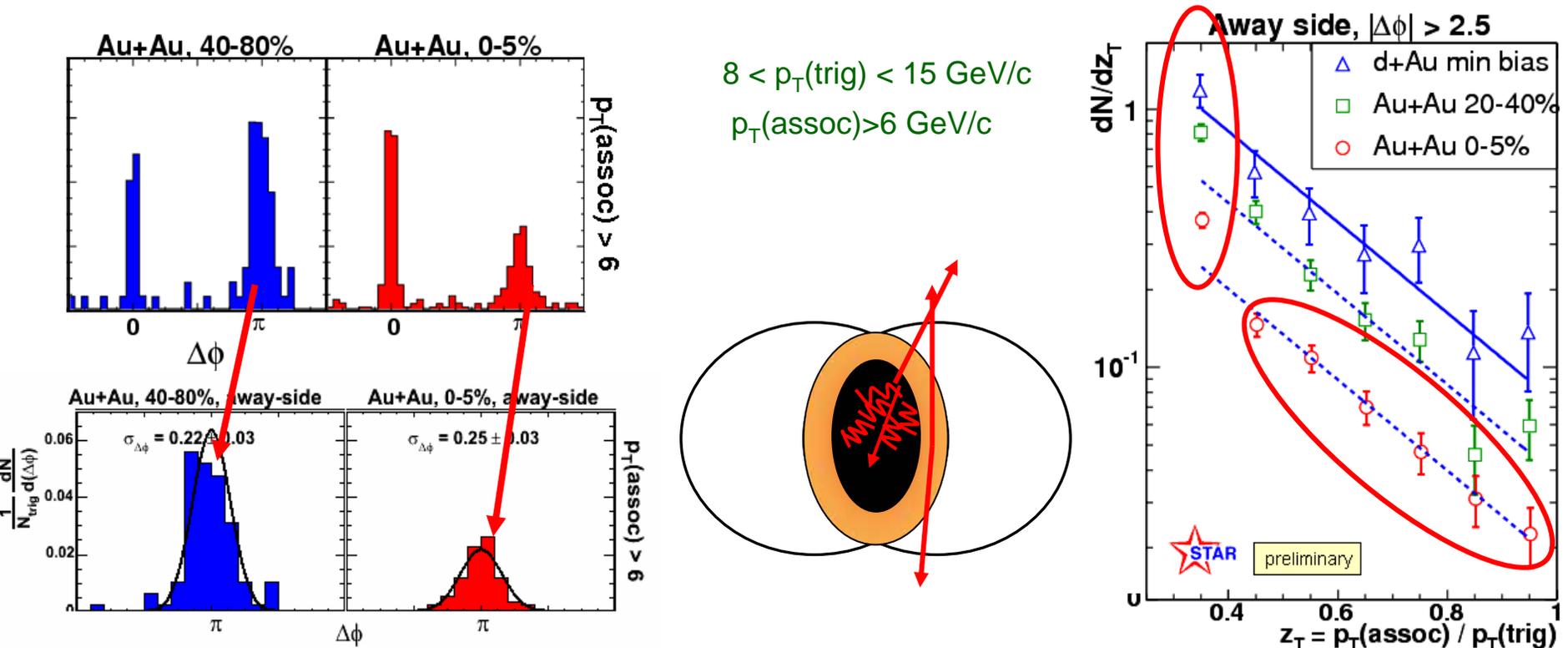


Near side jet yield is constant with centrality.

Clear away side peak

Suppression of away-side peak increases with centrality

Di-jets at high p_T : STAR



Clear emergence of jet structure at the away-side

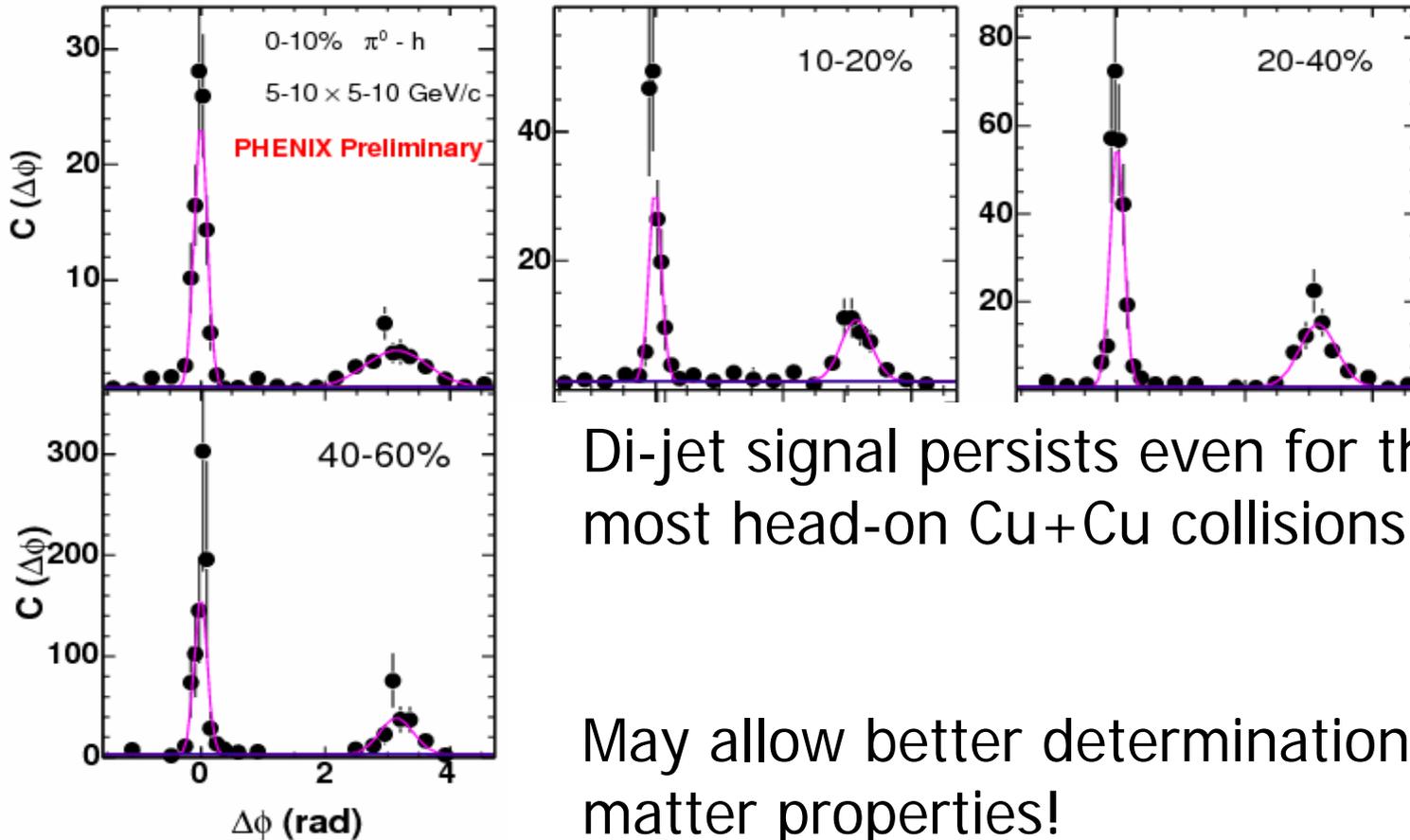
Away side width consistent with constant

Away side yield is suppressed in central collisions

But the amount of suppression is independent of $p_{T,assoc}$ for $p_{T,assoc}/p_{T,trig} > 0.4$ (i.e. large $p_{T,assoc}$)

Small modifications require both jets emitted from surface, results in a tangential emission pattern

PHENIX: Cu+Cu high p_T Jet Correlations



Di-jet signal persists even for the most head-on Cu+Cu collisions.

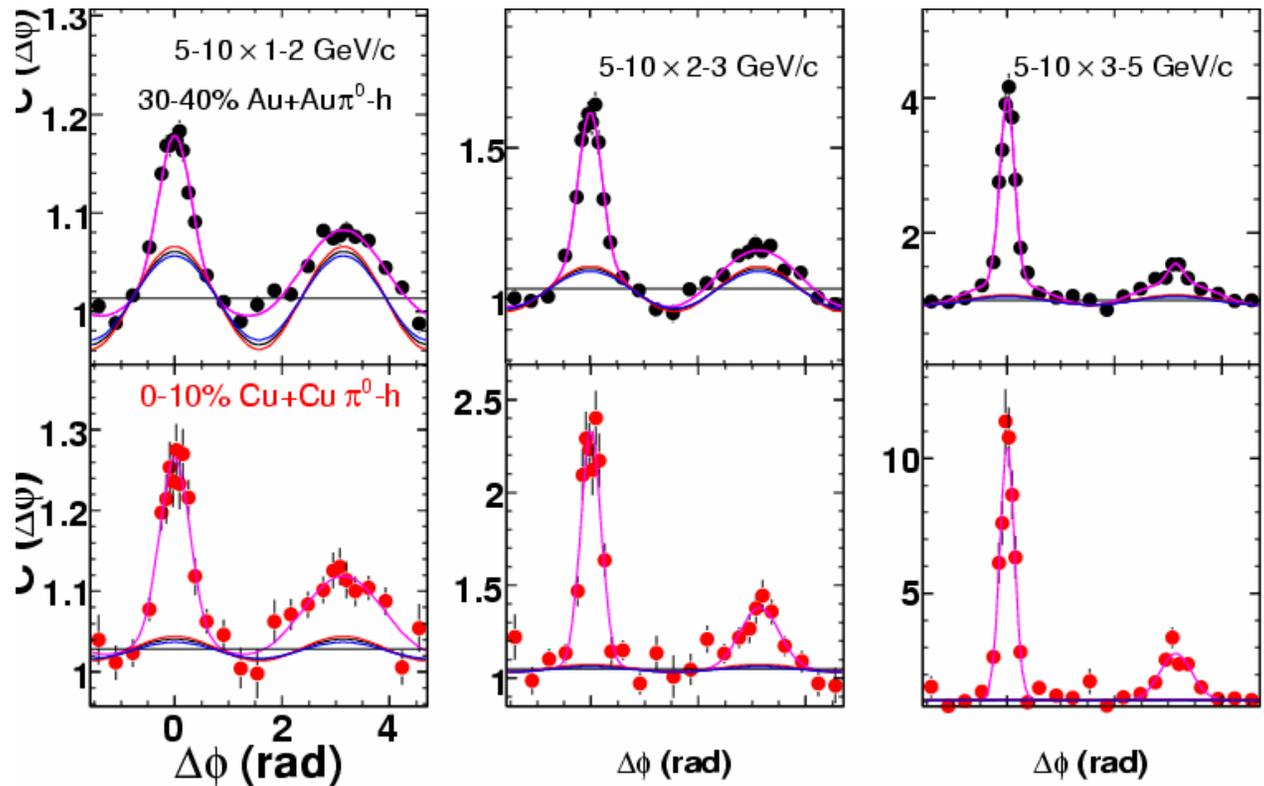
May allow better determination of matter properties!

Comparison Au + Au and Cu + Cu

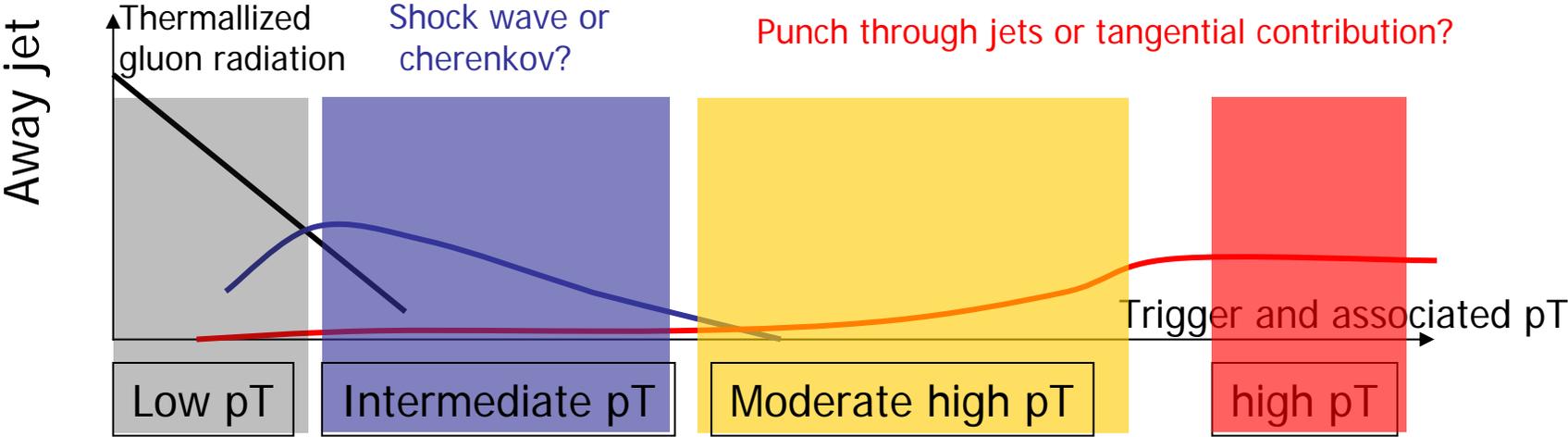
- Npart and Ncoll between the two are close
- The comparison between the two could provide constrains on the collision geometry dependence of the modification

30-40% Au+Au
Npart = 114

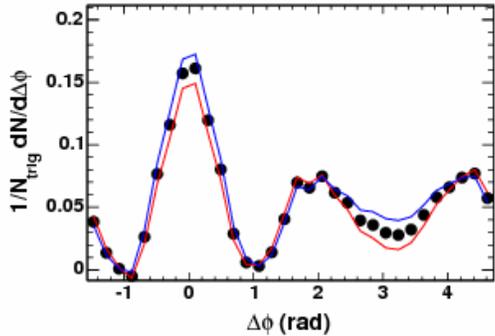
0-10% Cu+Cu
Npart = 98



One of the possible pictures? (personal)

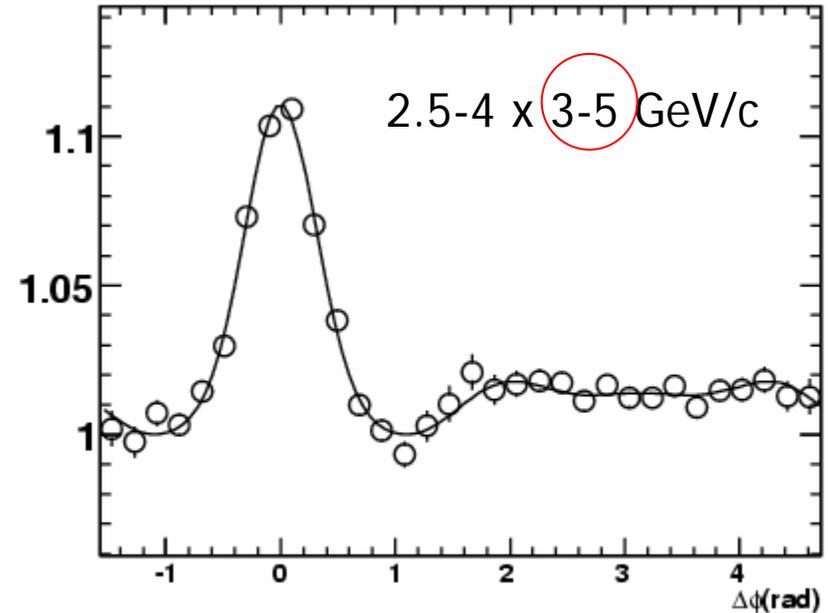
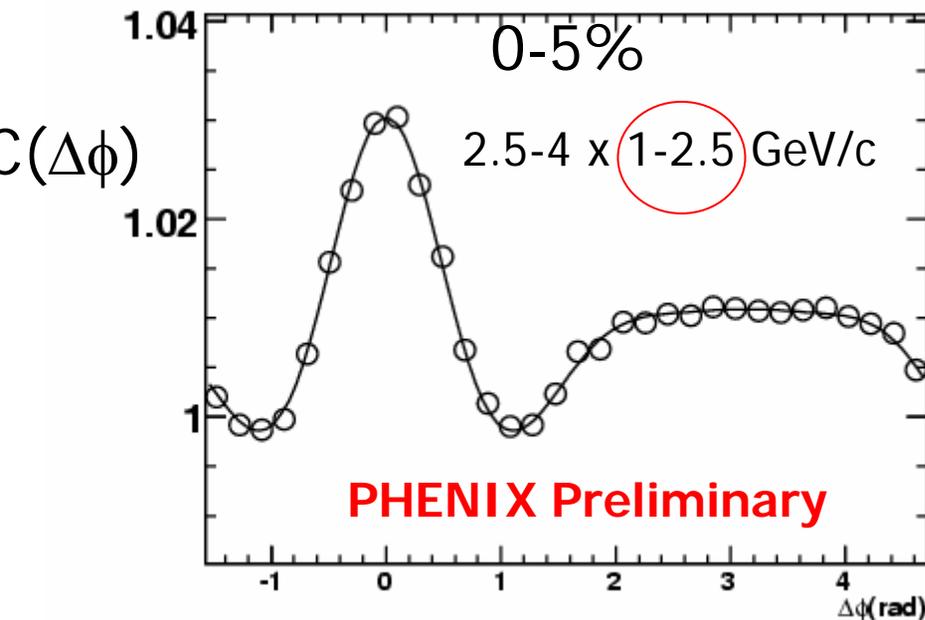


- Intermediate/ Moderate high pT correlation is important for connecting the low pT with high pT regions
 - How robust is the away side jet shape?
 - Jet yield in different regions?



How robust is the away side jet shape?

$$C(\Delta\phi) = \frac{dN_{pair} / d\Delta\phi}{dN_{mix} / d\Delta\phi}$$



Raw CF shows flat or slight dip at the away side!
Shape is not gauss, can't be pure random walk broadening
Small jet signal! (1/50), understand v_2 is important!

Now subtract the flow contribution

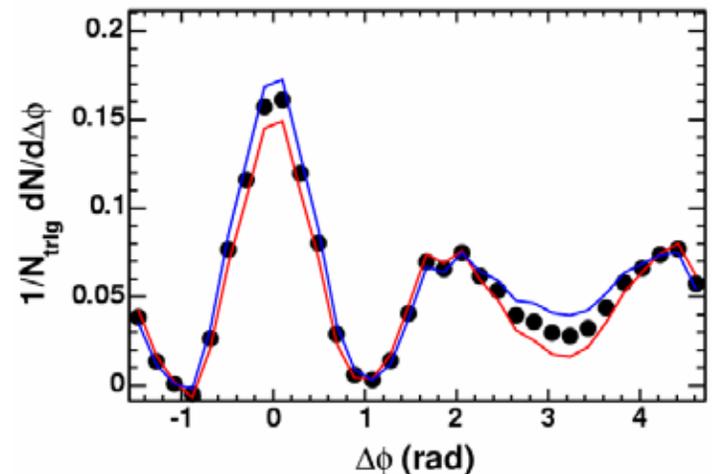
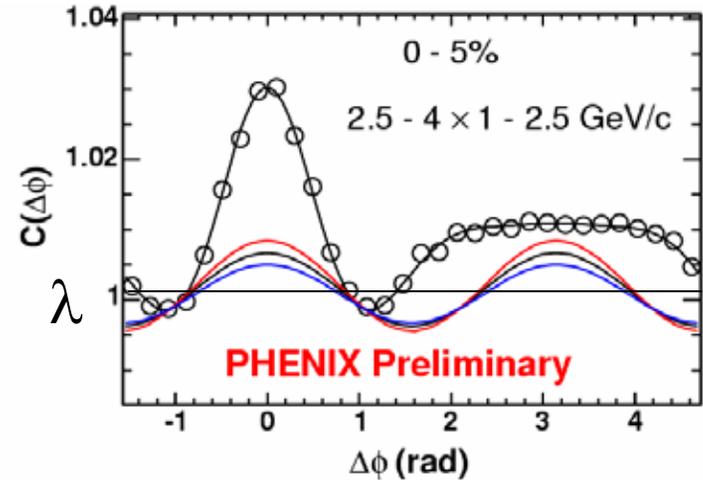
$$CF = J(\Delta\phi) + \lambda(1 + 2v_2^t v_2^a \cos 2\Delta\phi)$$

- v_2 background is scaled to match the correlation function (ZYAM)

ZYAM used by both PHENIX and STAR.

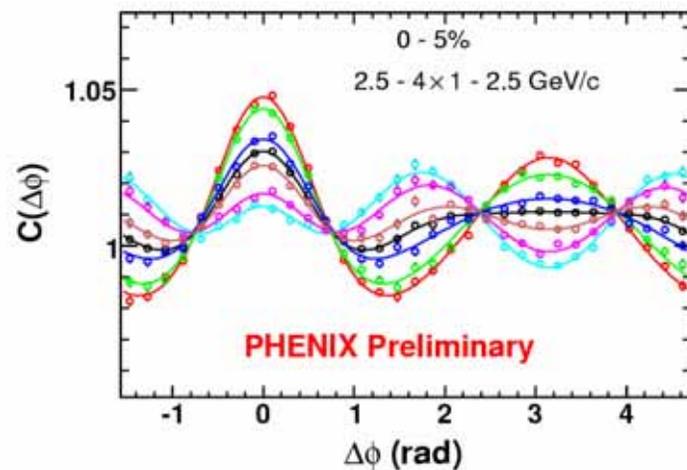
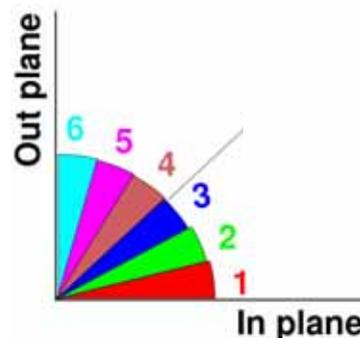
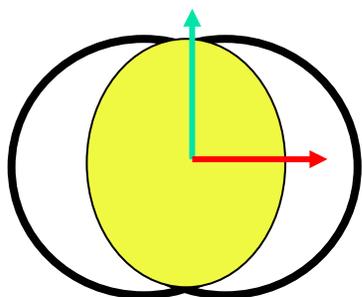
- Shape is not sensitive to λ

- But sensitive to the v_2 systematic.

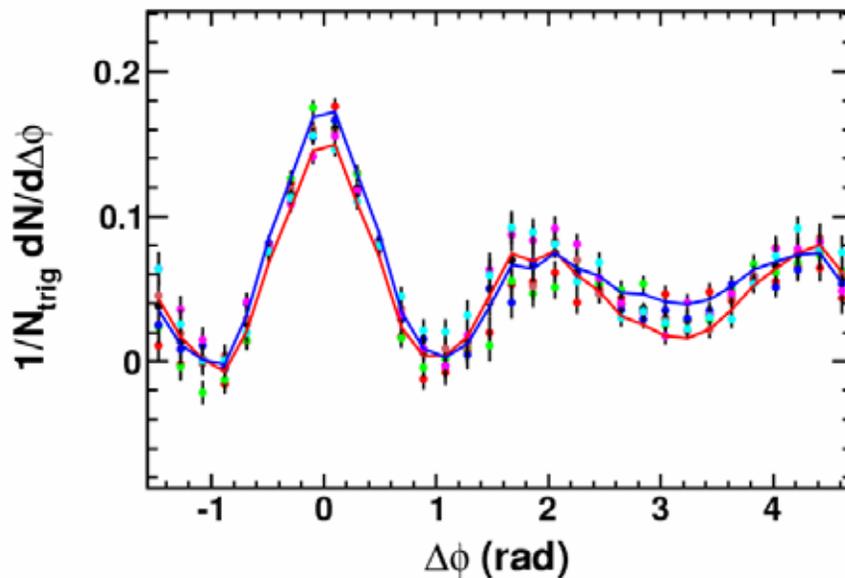


Shape can be constrained by the RP dependence

- Measure CF in six different reaction plane directions
- Flow change dramatically vs trigger bin

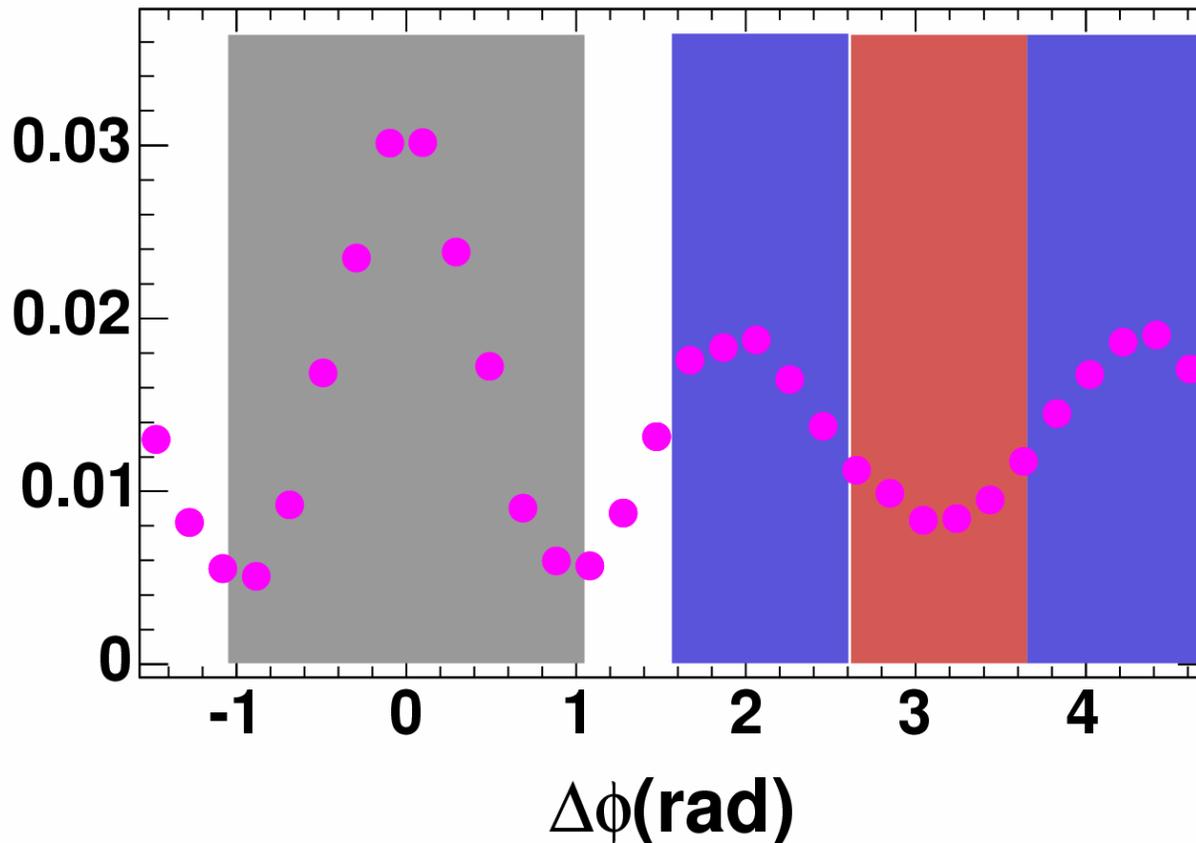


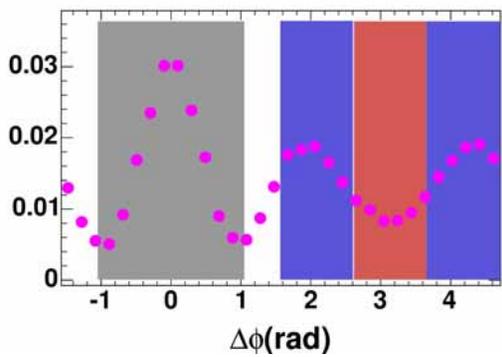
- However, the subtracted distribution agrees in errors
- **Shoulder** and **dip** seen in all bins.



Jet yield in different regions

- Three regions:
 - **Near** $|\Delta\phi| < \pi/3$.
 - **Away dip** $|\Delta\phi - \pi| < \pi/6$,
 - **Away peaks** $\pi/2 < \Delta\phi < 5\pi/6$, $7\pi/6 < \Delta\phi < 3\pi/2$
- Disentangle “Mach Cone” and “normal jet fragmentation” components???



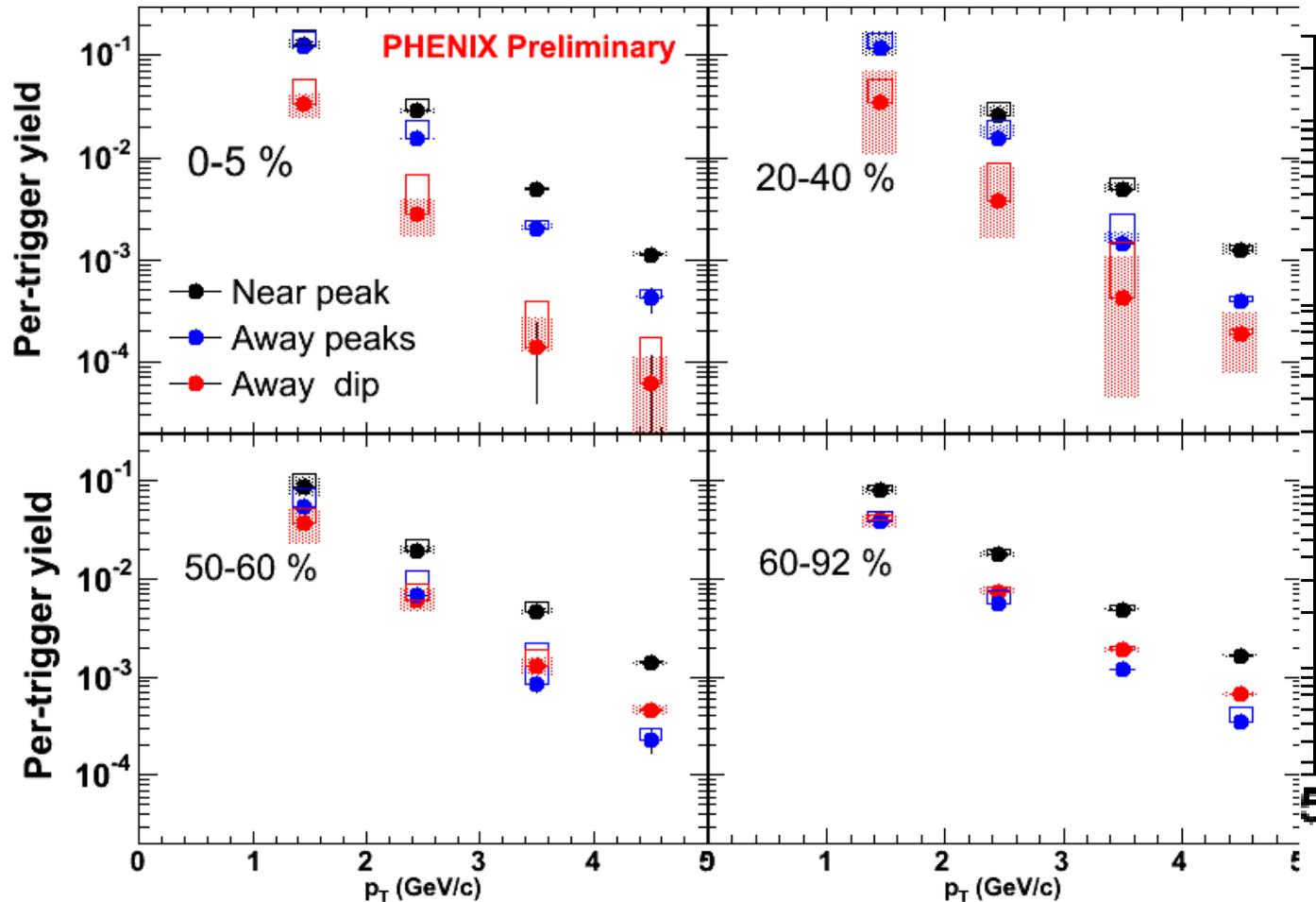


Jet yield: 3 regions, vs $p_{T,assoc}$

As centrality: central \rightarrow peripheral, p_T : low \rightarrow high, the dip region tends to be filled

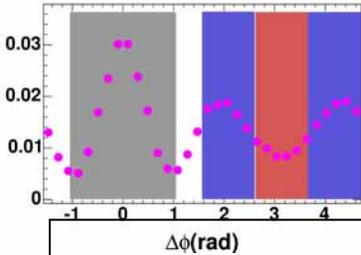
\Rightarrow

Trigger: 2.5 – 4 GeV/c



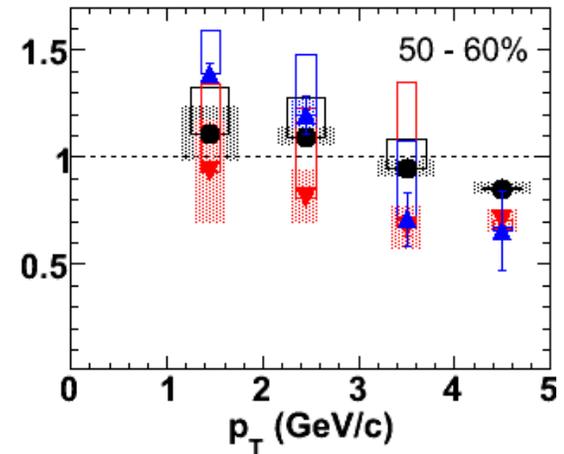
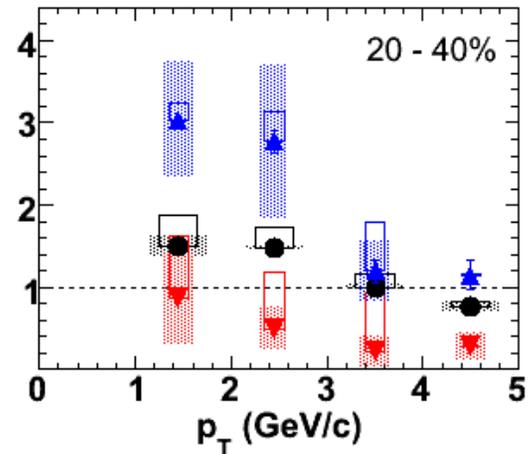
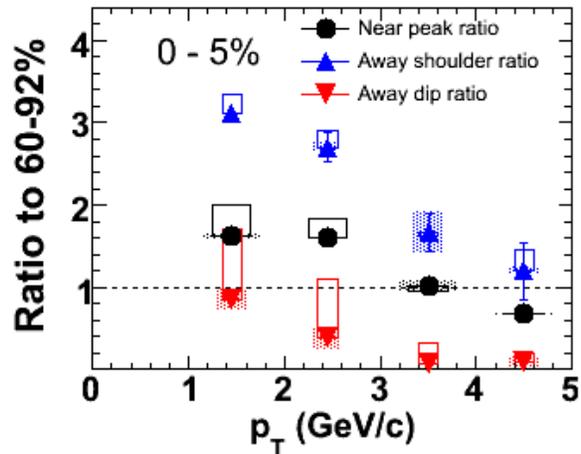
Ratio to peripheral collisions

Ratio of per-trigger yield: I_{cp}



Near side yield: similar to STAR publication

- enhancement at low $p_{T,assoc}$
- which decreases towards high p_T and close to 1 in peripheral collisions

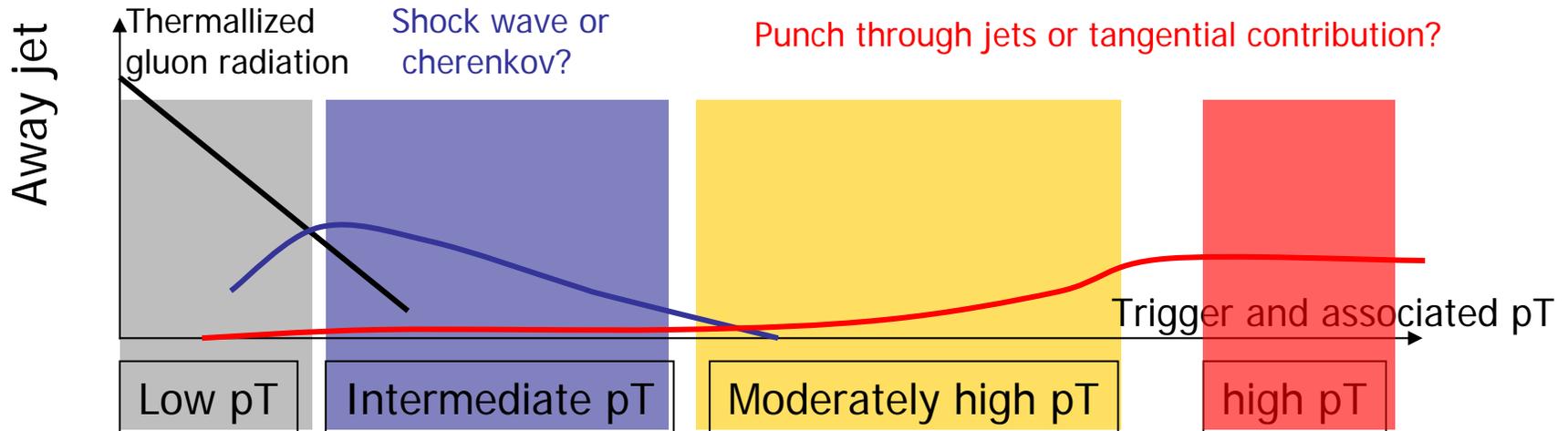


Away side

- shoulder: enhancement at low $p_{T,assoc}$ which decreases towards high p_T
- dip: always below 1 and decrease towards high p_T

Summary

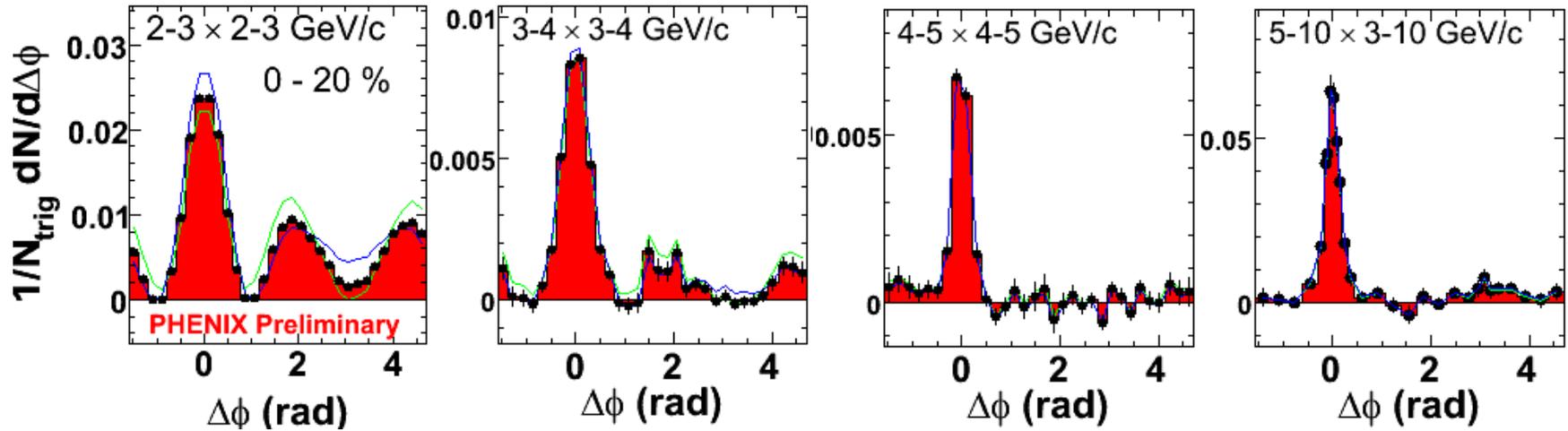
- Evolution of away-side jet shape
 - Qualitatively divides into four regions : low pT, **intermediate pT**, moderately high pT, **high pT**
 - Different physics modification at different regions:



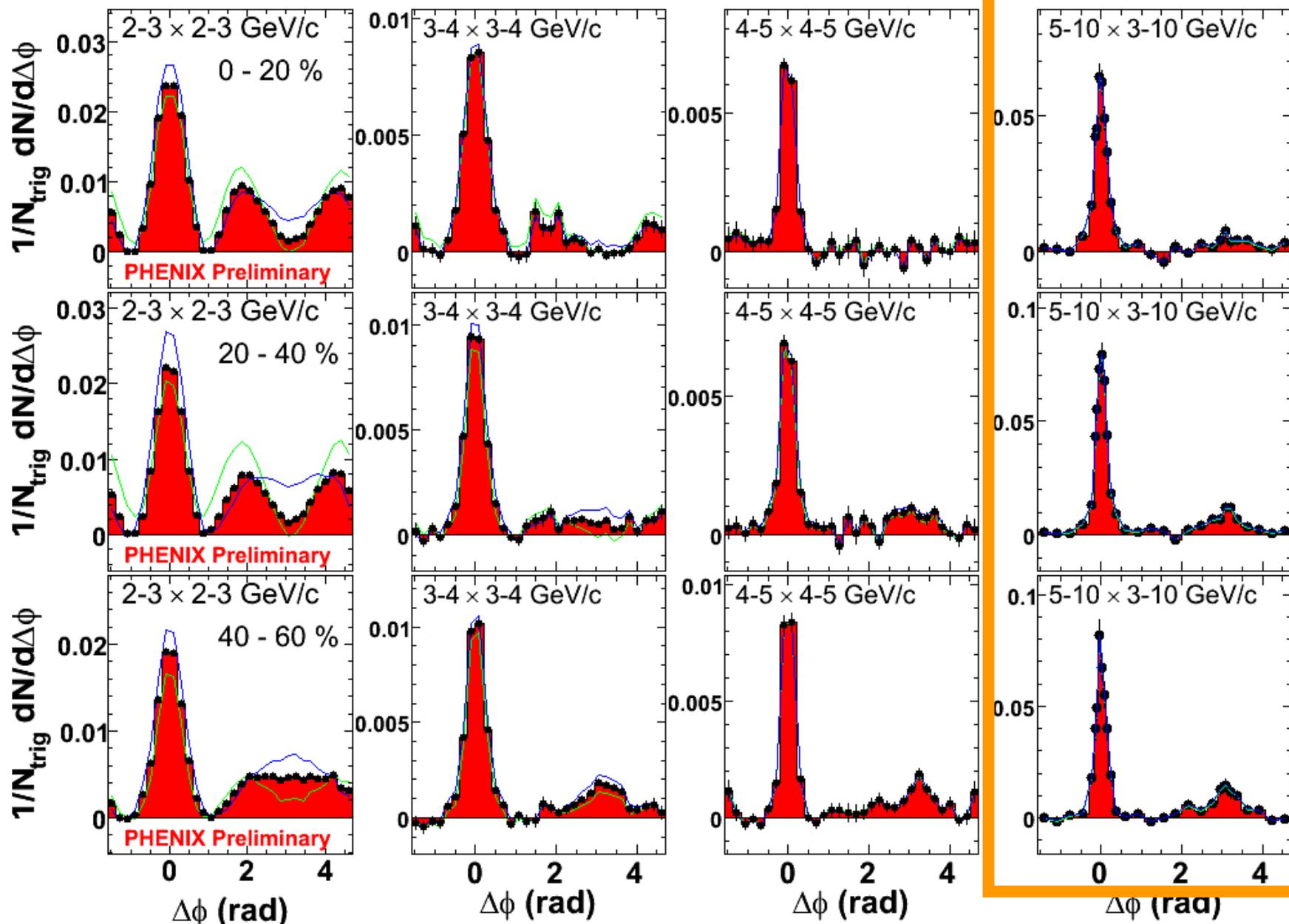
- Away side jet shape in 0-5% central Au + Au
 - Raw correlation at away side is flat or small dip
 - After subtraction, jet signal shows double peak structure
- Remarkable pT and centrality dependence of jet yield
 - Enhancement in shoulder region at low pT (< 2-3 GeV/c?)
 - Suppression in the dip region
 - Modification dies out towards peripheral collisions.

Back up

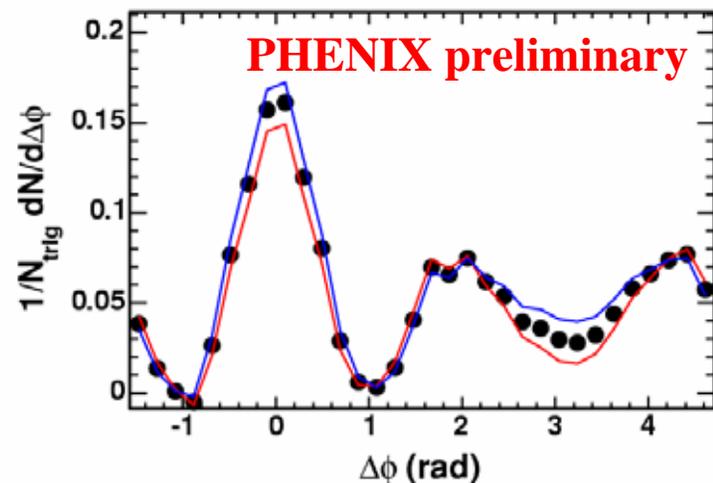
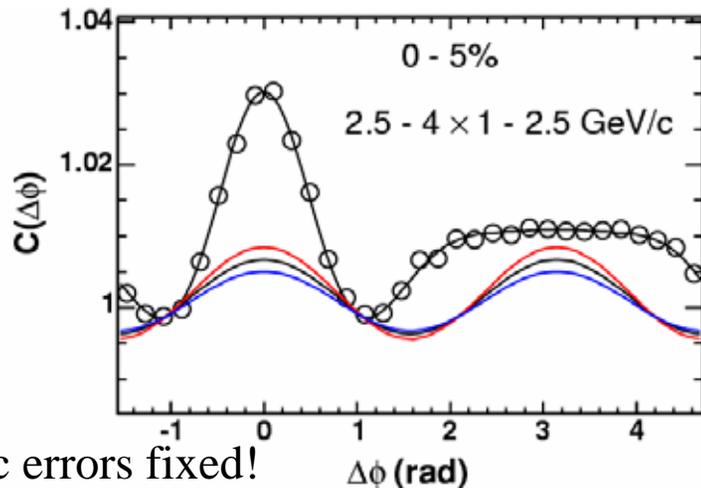
Evolution of away-side jet shape



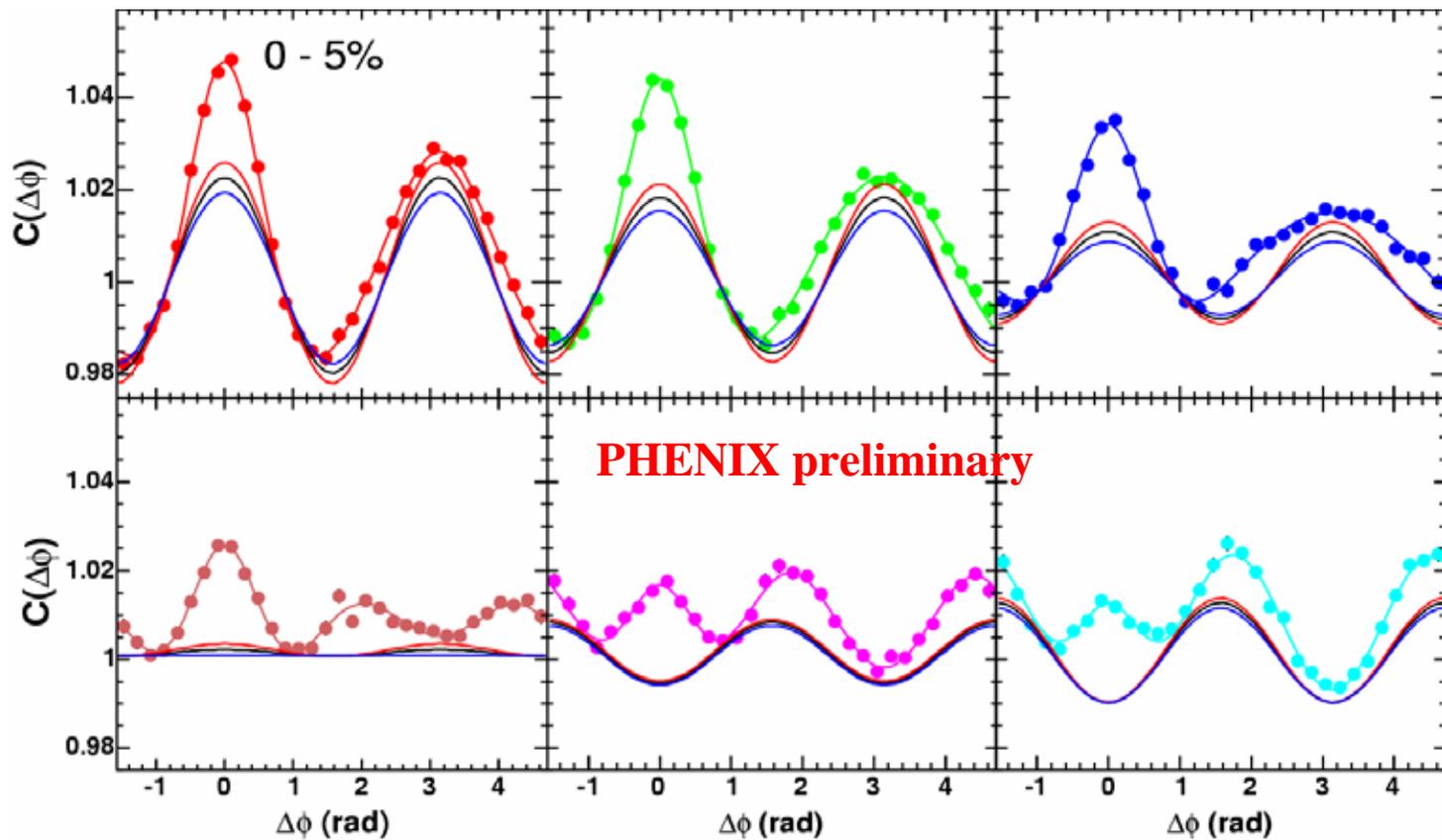
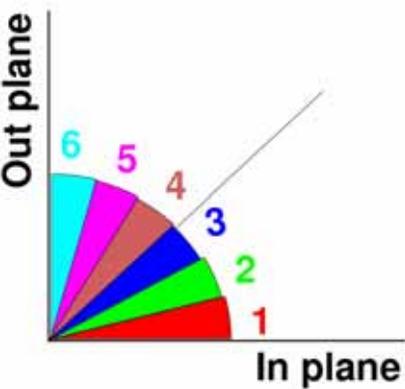
Evolution of away-side jet shape



0-5%



ξ is fixed ! systematic errors fixed!
v4 not included.



Fix trigger, vary associated

- Fix trigger \rightarrow fix the strength of the probe
- Significant distortion at low p_{Tassoc} \rightarrow expect strong modification of fragmentation function at low z_T

